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Research Article

Economics of chhari and marketable-size carps in Bara, Nepal

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ABSTRACT

A study was conducted to analyze the economics of production of chhari and marketable-size carps in Bara, Nepal. All total 90 farmers; 45 chhari producing and 45 marketable-size carps producing farmers were selected randomly and surveyed through pre-tested semi-structured interview based schedule on the month of March, 2019. Data was entered and analyzed using STATA 12.1 and SPSS 25. Findings of the study revealed that the total cost of fish production per hectare of pond area was 971927 NRs/year. Chhari production was profitable in the study area as compared to marketable-size carps with a Benefit Cost Ratio of 1.97 and 1.67 respectively. Production function analysis including six explanatory variables, showed significant effect of feed, labour ($p<0.01$), maintenance, fuel and electricity ($p<0.05$) and lime, fertilizer and medicine costs ($p<0.1$) but seed cost was insignificant. The return to scale was found to be 0.906 and at II stage of Production. According to estimated allocative efficiency indices, it is suggested to reduce seed; and lime, fertilizer cum medicine cost by 159% and 72% respectively, and increase the maintenance; feed; fuel cum electricity; and labour cost by about 95%, 33%, 95%, and 50% respectively for chhari producers. Similarly for marketable-size carp producers, it is suggested to decrease fuel and electricity cost by 176% and increase maintenance; seed; feed; lime, fertilizer and medicine; and labour cost by 95%, 86%, 13%, 29%, and 30% respectively. Thus, fishery enterprise is in the stage of higher potentiality to increase the production in the study area.

Keywords: Chhari; marketable-size carps; Benefit Cost Ratio; Resource-use efficiency; Cobb-Douglas Production Function.

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INTRODUCTION

Aquaculture is one of the major sectors of Nepalese economy and provides livelihood service to more than 3% of the total population which nearly includes 741,000 individuals. Around 138,439 people have got employment opportunities due to aquaculture (FAO, 2019). Fisheries sector alone contributes 14,660.72 million NPR as reported by Central Bureau of Statistics, 2019 which is the maximum of all time since 2001(CEIC, 2019). The per capita consumption of fish is 3.1 kg (2017/18) which is much higher than that of 2003/04 i.e. 2.1 kg. The growing demand is thus fulfilled by importing the fish from nearby country India. Thus, development of fisheries and aquaculture is a key for the enhancement of Nepalese economy (MOALD, 2018).

According to Nepal fishery survey 2072, aquaculture practice is seen in 65 districts of Nepal where 93% of the total pond area is under cultivation of big fishes(average 1-1.5 kg) and remaining 7% of the pond is under chhari fish (average 50gm) production. Generally 0.25 to 3 kg size of carps are called as marketable-size or table-size carps. But, the range may vary from country to country (FAO, 2018). Among 77 districts, Bara is the leading producer of fish which solely contributes 18.5% of the total fisheries production of Nepal which is followed by Saptari, Chitwan, Dhanusa, Rupandehi, Rautahat etc. (CFPCC, 2018).

Carp polyculture is by far the most popular method of rearing fish in Nepal and has been adopted in large majority of fish farming communities. All seven species are included in a same pond, so that the resources are utilized wisely. But, for this, stocking density of different species should be optimum. Recently, chhari fish i.e., small-sized whole fish of mostly mrigal (*Cirrhinus mrigala*) and some amount of rohu (*Labeo rohita*) approximately 10%, is also popular among farmers. The small size of chhari fish ranging from 20 g to 100 g in size is appropriate for dried fish product. As the fish is harvested in small size, multiple harvesting is more compatible for chhari. Generally, chhari fish production system is prevailing in some parts of terai district like Bara, Parsa, Rautahat, Saptari and Morang districts. Fish rearing using chhari production system was developed by the farmers themselves using indigenous technical knowledge which involves raising fish from the fry/fingerling stage to the point when they reach 40-60 g of commercial size (Pradhan *et al*., 2018). The demand of chhari has been increasing day-by-day thus the adoption rate of chhari production system is also rising. However, the current practices in chhari production system needs to be commercialized and improved with effective research for the better social transformation of the rural poor farmers.

According to Adhikari and Bjørndal (2009) it is more profitable and cost effective to increase the efficiency of available inputs rather than modifying and changing the existing technology. Information on economic viability of fish farming is crucial to the investors for making decision. Unfortunately, such information has been scarce in Nepal. Farmers are lacking appropriate management skills and use inappropriate amount of resources. It is due to the lack of information regarding the resource use efficiency. So, this study was conducted to analyze the economics of production and resource-use efficiency of chhari and marketable-size carp production system in Bara, Nepal.

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MATERIALS AND METHODS

Study area

The study was conducted at Bara district, Nepal where Prime Minister Agriculture Modernization Project (PM-AMP) has been implementing. The study site is one of the southern Terai district of Narayani zone and a part of Province No.2 of Nepal.The district covers an area of 1190 square kilometers with total population of 6,87,708 (CBS, 2011).

Data collection and Sampling Procedure

For the study purpose, Simraungadh and Pachrauta municipalities and Bodhban fish production pocket of this district were selected, as these were the potential hubs for fish production in the district. Altogether 90 HHs, 45HH from Simraungadh and Pachrauta Municipalites and 45HHs from Bodhban fish production pocket, Kolhabi Municipality were taken under consideration according to the Slovin's formula. In this research, farmers were categorized as chhari producers and marketable-size carp producers under carp polyculture system, based on the size of fish harvested.

The primary data were collected through administering pre-tested semi-structured interview schedule, Focus Group Discussion and Key Informant Interview (KII) while the secondary data sources were Central Bureau of Statistics, various journals, reports from Ministry of Agriculture and Livestock Development, Agriculture Knowledge Centre, Bara, PM-AMP etc.

Data analysis

Qualitative and Quantitative analysis was done using SPSS version 25 (Arkkelin, 2014; Shrestha & Shrestha, 2017), Ms-Excel 2007 and STATA version 12.1. Sample t-test was applied for determining the significant differences between the means (Dhakal *et al*., 2015).

Cost, Return and Profitability:

Total costs are the sum of the total fixed cost and total variable costs. When no variable input is used TC=TFC. Symbolically,

$TC = TFC + TVC$

Where, TC= Total cost, TFC = Total fixed cost, TVC = Total fixed cost

Variable cost refers to recurring type of costs and is also called operational costs or working cost. Total variable cost is computed by multiplying the amount of variable input by per unit price of input. In the study, the following variable costs were undertaken.

$TVC = C_{labour} + C_{lime} + C_{feed} + C_{medicine} + C_{fertilizers} + C_{fuel\ and\ electricity} + C_{pond\ maintenance} + C_{seed}$

Where, C_{labour} = Total cost of labour in NRs., C_{lime} = Total cost of lime in NRs., C_{feed} = Total cost of feed in NRs., $C_{medicine}$ = Total Cost of medicines in NRs., $C_{fertilizers}$ = Total cost of fertilizers in NRs., $C_{fuel\ and\ electricity}$ = Total cost of fuel and electricity in NRs., $C_{pond\ maintenance}$ = Total cost for pond maintenance in NRs., C_{seed} = Total cost of fish seed in NRs.

Fixed cost refers to the cost that remains unchanged irrespective of the level of output produced. In this study land rent, depreciation of tools, equipment, machinery, farm/ buildings were included under fixed cost.

$TFC = C_{land\ rent} + C_{depreciation} + C_{interest}$

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Where, $C_{\text{land rent}}$ = Total land rent per year in NRs., $C_{\text{depreciation}}$ = Total depreciation cost in NRs., C_{interest} = Total interest on initial investment.
Interest was charged at the rate of 12% according to the prevailing interest rate. Similarly, depreciation was charged at the rate of 10% per annum on an average for different equipment and machineries used in fish farms like pipes, motor, pump set, generator, boring, aerator, fishing net, farm buildings, etc.
Benefit-Cost Ratio (BCR) refers to the ratio of gross margin (NRs. /ha) to the total cost (NRs. /ha) incurred. BCR greater than 1 indicates the investment yields profit and feasibility of business. BCR was calculated by dividing the total revenue by total cost (Tunde *et al.*, 2015).
BCR= TR/TC
Where, BCR= Benefit-Cost Ratio
TR= Total Revenue
TC= Total Cost

Gross Margin is the difference between the total revenue obtained per kg of the farm and the total variable cost per ha incurred to that which can be written symbolically as,
Gross margin (NRs. / ha) = Revenue/ ha– Total variable cost (TVC)/ ha
Profit/net margin refers to the difference between total gross margin and the fixed cost which can be calculated as,
Net Margin (NRs. / ha) = Gross margin (NRs. / ha) – Total Fixed Cost (TFC)/ ha

Production Function Analysis
Production function is the systematic way of showing relationship between different amounts of inputs that can be used to produce a product and the corresponding output of that product. Cobb-Douglas production function analysis is widely used tool in agricultural resource for determining production function analysis (Dhakal *et al.*, 2015). Following form of production function was used to examine resource productivity, efficiency and return to scale as estimated by Saha *et al.,* (2004) and Tunde *et al.* (2015).
$Y = aX1^{b1}\, X2^{b2}\, X3^{b3}\, X4^{b4}\, X5^{b5}\, X6^{b6} e^{u}$
The equation was then linearized using log transformation and then method of least squares was used as suggested by Prajneshu (2008).
Taking log on both sides,

$$lnY = lna + b1lnX1 + b2lnX2 + b3lnX3 + b4lnX4 + b5lnX5 + b6lnX6 + u$$

where,

Y= Gross return (NRs/ ha) = Total quantity produced (kg/ha) × Price of fish (NRs. /kg)
a = Constant or Intercept of the function,
X1 = Pond maintenance cost in NRs. /ha,
X2 = Hatchling/fry/fingerling cost in NRs. /ha
X3 = Feed cost in NRs. /ha,
X4 = Lime, Fertilizer and medicine cost in NRs. /ha,
X5 = Fuel and electricity cost in NRs. /ha,

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X6 = Labour cost in NRs. /ha
ln= Natural log
u= error terms
b1, b2, b3…. = Coefficient of respective variables

Cobb-Douglas function was assumed as the functional form of the production function. This was because it is linear in its logarithmic form, and therefore easy to estimate by using ordinary least squares estimation technique (OLS).

The elasticity of production is the measure of responsiveness of output to changes in input. It is the proportionate change in output as compared to proportionate change in input. In the Cobb-Douglas model, elasticity of production/ return to scale is calculated by the summation of all the coefficients of individual inputs. If the sum of the coefficients is larger than one, the production function has increasing returns to scale. If the sum of the coefficients is less than one, returns to scale are decreasing, while if they are equal to one, there are constant returns to scale (Cobb & Douglas, 1928).

Resource use efficiency

According to Das *et al*. (2016), resource use efficiency (r) is estimated by dividing the Marginal value product (MVP) by Marginal factor cost (MFC). The marginal fixed cost was taken as 1 for all the input's cost. The marginal value products (MVPs) of the input used were estimated by multiplying the Average value product (AVP) of an input with its elasticity of production (bi). Elasticity of production was obtained in production function analysis. AVP was obtained by dividing the geometric mean of output to the geometric mean of input. The obtained value was tested for its equality to one i.e. (MVP/MFC) =1.
Here, r = MVP/MFC where, r = Efficiency Ratio

The decision criteria are:

- If r = 1, optimum/efficient utilization of resources.
- If r < 1, overutilization of resources.
- If r > 1, underutilization of resources (Toma *et al.,* 2015)

Percentage adjustment required or Divergence (%) was calculated as adopted by Goni *et al.,* (2013),
Or, D= (1-1/r)×100
Where, D= absolute value of percentage change in MVP required in each resource.

RESULTS AND DISCUSSION

Socio-economic characteristics

The average age of respondents was about 39.89 for chhari producers and 48.64 for marketable-size carp producers with 9.24 and 15.88 years of fish farming experiences respectively. The average Household (HH) size was found to be 7.42 and 6.46 for chhari and marketable-size carp production system. It was also found that 93.30 of the total respondents were Hindu followed by 6.70% Muslims in the study area. 77.80% of the total respondents

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were male while 22.20% of the total respondents were female. From the study it was found that 82.22% of the respondents were literate and remaining 17.78% were still illiterate in the study area. The average pond area holding of the respondents was found to be 1.34 hectare (ha).

Cost of Production

Economics play a major role on the sustainability and development of fish farming enterprise. Though technical proficiency is mandatory in aquaculture, if the farm is uneconomical in commercial aspect, it is of no use (Tisdell, 2001). Table 1 presents the cost of fish production per hectare per year in the study area. The average cost of fish cultivation was found to be Rs. 971927.37/ha. Out of which, the share of feed was 29.54%, labour was 27.70%, fish seed (hatchling, fry, fingerling) was 3.19%, fuel and electricity was 3.19%, manure and fertilizers was 2.68%, medicine was 0.76%, maintenance was 0.64%, lime was 0.66%, depreciation on machinery was 0.67%, land rent was 21.31% and interest on investment was 9.66%. The total fixed cost (TFC) was NRs. 307478.34/ha which accounted for the 31.64% of the total cost and the total variable cost (TVC) was NRs. 664448.99/ha which accounted for 68.36% of the total cost. Similar findings were obtained by Sharma *et al.,* (2018) where feed cost contributed 28% and labour cost contributed 25% to the total cost incurred during production process. Yemi and Okiemute (2008) also obtained similar findings where variable cost accounted for 72.95% and fixed cost accounted for 27.05% of the total cost. The result was also in consistent with Okpeke and Akarue (2015).

Table 1: Cost structure for chhari and marketable-size carp production system

Particulars (NRs./ha)	Cost NRs.	Frequency
Variable cost items		
Hatchling/ Fry/ Fingerling	31001.17(5385.69)	3.19
Feed	287159.39(57738.80)	29.54
Fuel and electricity	31087.50(4738.24)	3.19
Lime	6367.14(6881.84)	0.66
Manure and fertilizers	26009.77(29052.79)	2.68
Labour	269222.34(67552.06)	27.70
Medicine	7365.12(9380.31)	0.76
Maintenance	6236.56(1591.23)	0.64
TVC	664448.99	68.36
Fixed cost items		
Landrent	207129.4(44345.11)	21.31
Depreciation	6509.03(3574.96)	0.67
Interest	93839.91(14019.21)	9.66
TFC	307478.34	31.64
TC	971927.37	100.00

Figures in parenthesis indicate S.D.

The cost structure for chhari and marketable-size carp production was estimated. The total cost (TC) of fish production per ha per year was NRs. 949828.53 in chhari producers and NRs. 994026.21 in marketable-size carps producers using carp polyculture techniques. The total variable cost shares 68.05% of the total cost in chhari producers and 68.67% in

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marketable-size carps producers.

Among the total cost, feed cost shares the highest percentage i.e. 33.31 in chhari producers followed by labour cost i.e. 23.91%, which does not matches well with marketable-size carps producers where labour cost shares the highest percentage i.e. 31.33% followed by feed cost i.e. 25.95%. The result shows that cost difference goes highly significant ($p<0.01$) with feed cost, fuel and electricity cost, seed cost, manure and fertilizer cost and labour cost. Interest was found to be moderately significant ($p<0.05$), medicine cost was found to be less significant ($p<0.1$), lime and pond maintenance cost was not significant at all i.e. both the categories have uniform lime use and uniform level of pond maintenance.

Table 2: cost comparison between chhari and marketable-size carps production

Particulars (NRs./ha)	Chhari (NRs./ha)	Marketable size-carps NRs./ha)	Mean difference	t-test
Variable cost items				
Hatchling/ Fry/ Fingerling	32988.54	29013.81	3974.73	3.749***
Feed	316416.04	257902.74	58513.3	5.555***
Fuel and electricity	33178.4	28996.59	4181.8	4.645***
Lime	6551.93	6182.36	369.57	0.253
Manure and fertilizers	14587.92	37431.63	-22843.71	-4.04***
Labour	227060.42	311384.25	-84323.82	-7.56***
Medicine	9183.24	5547.01	3636.23	1.864*
Maintenance	6381.13	6092	-378.49	0.861
TVC	646347.62	682550.39	-36202.76	-1.712*
Fixed cost items				
Landrent	206740.7	207518.07	-777.367	-0.083
Depreciation	6495.46	6522.6	-27.13	-0.036
Interest	90244.7	97435.11	-7190.41	-2.504**
TFC	303480.87	311475.79	-7994.92	-726
TC	949828.53	994026.21	-44197.68	-1.617

, ** and * significant at 10%, 5% and 1% level, respectively.*

Benefit Cost Ratio

The total cost of two different types of fish producers, income from production, gross margin, and net margin along with Benefit Cost Ratio are presented in Table 3. The undiscounted BCR is simply the ratio of gross return to total cost incurred. The BCR was found to be 1.97 in chhari fish producers and 1.67 in marketable-size carps producers which was found to be significantly different ($p<0.01$). The result was in line with Adewuyi *et al.,* (2010); Olaoye *et al.*(2012); and Olasunkanmi (2012). Similar results were also obtained by Tunde (2015) where BCR from fish farming was found to be 1.9 indicating fish farming as a highly

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profitable endeavour. The result portrays that chhari size fish production or chhari production system is profitable in the study area as compared to the marketable-size carp production using carp polyculture techniques. Similar results were also found by Singh (2007) where fish production yielded better remunerative to the fish farming household.

Total income from fish production, gross margin, net margin and BCR were found to be significantly higher (p<0.01) for chhari fish production system as compared to marketable-size carps production system. Both system of fish farming were found to be profitable in the study area. Kassali *et al.,* (2011) also obtained similar findings, where rate of returns on investment was found to be 61% for fish farming.

Table 3: Comparative total costs, net margin and benefit cost ratio

Particulars (NRs./ha)	Chhari (NRs./ha)	Marketable-size carps (NRs./ha)	Mean difference (NRs./ha)	t-value
Total Cost	949828.53	994026.21	-44197.68	-1.617
Income	1870384.77	1659953.91	210430.86	3.936***
Gross margin	1224037.12	977403.49	246633.62	6.222***
Net margin	920556.24	665927.70	254628.54	6.753***
BCR	1.97	1.67	0.30	7.831***

, ** and * significant at 10%, 5% and 1% level of significance, respectively,*

Production function analysis

Fish farming requires the use of various natural and artificial inputs. Each input has certain degree of role on the determination of fish production. All the inputs may not be equally essential. So, to assess the contribution of each input in fish farming extended Cobb-Douglas production function was applied, result of which is presented on the Table 4.

Six variables were estimated for their effects on production such as maintenance cost, fry/hatchling/fingerling cost, feed cost, lime, fertilizer and medicine cost, fuel and electricity cost and labour cost. Out of six variables, two variables such as feed cost and labour cost were significant at 1 percent level, two variables such as maintenance cost and fuel and electricity cost were significant at 5% level, lime fertilizer and medicine cost was significant at 10% level and hatchling/fry cost was insignificant. The regression coefficient for feed cost was 0.345, which had depicted that with 100% increase in cost of feed, income could be increased by about 34.5%. Correspondingly, 100% increase in cost of labour, seed cost, maintenance cost, fuel and electricity cost and lime, fertilizers and medicine cost, income could be increased by 13.7%, 8.5%, 8.6%, 22.5%, and 2.8%. Coefficient was positive for hatchling/fry/fingerling cost but was insignificant. The study carried by Debnath (2011) also yielded the similar results where the coefficients of major factors of production were found to be positive. Similar findings were obtained by Tunde *et al*. (2015), where feed and lime had significant (p<0.05) role in production and the fish seed was found to be positively affecting production, though not significant at any level of significance.

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The coefficient of determination (R^2) of the model was 0.6272 which means that 62.72% of the output is explained by the estimated model or the inputs considered in the function has 62.72% role in determining total income. The value of adjusted R^2 was 0.6003 indicating that after taking into account the degree of freedom (df) 60.03% of the variation in the dependent variable was explained by the explanatory variables included in the model. The F-value was found to be 23.28, which is highly significant ($p<0.01$) that depicts that all the inputs included in the model were important for explaining the variation in total revenue obtained from fish production in the study area. The result was in line with Mkong *et al.,* (2018); Olagunju *et al.,* (2007); and Singh (2007).

Table 4: Cobb-Douglas production function Analysis for Fish Production

Factors	Coefficients	Std. Error	t-value
Constant	4.047***	1.002	4.04
Pond maintenance cost (NRs./ha)	0.086**	0.042	2.02
Fry/Fingerling cost (NRs./ha)	0.085	0.065	1.32
Feed cost (NRs./ha)	0.345***	0.064	5.36
Lime, fertilizer and medicine cost (NRs./ha)	0.028*	0.015	1.92
Fuel and electricity cost (NRs./ha)	0.225**	0.094	2.40
Labour cost (NRs./ha)	0.137***	0.044	3.09
F-value	23.28		
R square	0.6272		
Adjusted R square	0.6003		
Return to scale	0.906		

, ** and * significant at 10%, 5% and 1% level of significance*

Returns to scale/ Elasticity of Production

Estimation of returns to scale is important because it indicates at what scale firms are most efficient. The sum of the coefficients of different variable inputs i.e. return to scale was found to be 0.906 for fish production. This indicates that the production function exhibited a decreasing return to scale and implies that 1 percent increment in all the inputs included in the function will increase income by 0.906 percent. The enterprise lies in the second stage of production. This finding is in consistent with that of Sharma *et al*. (2018) where decreasing return to scale was obtained and with Timothy and John (2011) in their study on analysis of profitability of fish farming among women in Osun State, Nigeria.

Resource Use Efficiency

Resource use efficiency in agriculture mainly includes technical efficiency, allocative efficiency, and environmental efficiency. An efficient farmer allocates his land, labour, capital and other resources in an optimal manner, so as to maximize his gross revenue, at least cost, on sustainable basis. The estimated MVP of different inputs used in fish production is presented in Table 5 for chhari production system.

The study of resource use efficiency in chhari production system revealed that ratio of MVP to MFC of the pond maintenance, feed cost, fuel and electricity cost and labour cost was positive and greater than one indicating their underutilization. Similarly, for the hatchling/

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fry/fingerling cost ratio is negative indicating the overutilization of resource. Likewise, in lime, fertilizer and medicine cost's ratio of MVP to MFC is positive and less than one indicating overutilization of resource. Similar findings were obtained by Adewuyi *et al.,* (2010) where increase in utilization of feed and labour was projected to increase the level of output substantially.

Table 5: Resource use efficiency for chhari production system

Inputs (NRs./ha)	Geometric Mean	Coefficient	MVP	MFC	MVP/MFC	Efficiency	Percent adjustment (D)
Pond maintenance cost (NRs./ha)	6192.727	0.069	20.62	1.00	20.62	Underused	95.15
Fry/Fingerling cost (NRs./ha)	32705.18	-0.030	-1.69	1.00	-1.69	Overused	159.17
Feed cost (NRs./ha)	312547.3	0.252	1.49	1.00	1.49	Underused	32.89
Lime, fertilizer and medicine cost (NRs./ha)	25281.26	0.008	0.58	1.00	0.58	Overused	-72.41
Fuel and electricity cost (NRs./ha)	32906.37	0.392	22.05	1.00	22.05	Underused	95.46
Labour cost (NRs./ha)	222938.9	0.241	2.00	1.00	2.00	Underused	50.00

The adjustment in the MVPs for optimal resource use in Table 5 suggested that for optimal allocation of resources, pond maintenance, feed, fuel and electricity and labour costs were required to increase by approximately 95%, 33%, 95% and 50% respectively. On the other hand, Hatchling/ Fry/ Fingerling cost and lime, fertilizers and medicine cost were required to be reduced by approximately 159% and 72% respectively.

The study of resource use efficiency in marketable-size carps production revealed that ratio of MVP to MFC of the pond maintenance cost, seed cost, feed cost, lime, fertilizer and medicine cost and labour cost was positive and greater than one indicating their under-utilization. On the other hand, for fuel and electricity cost the ratio was obtained negative which demonstrated its over-utilization and less profit could be derived by increasing feed cost.

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Table 6: Ratio of MVPs and MFCs of different inputs incurred in producing marketable-size carps in carp-polyculture system

Inputs (NRs./ha)	Geometric Mean	Coefficient	MVP	MFC	MVP/MFC	Efficiency	Percent adjustment (D)
Pond maintenance cost (NRs./ha)	5849.593	0.073	20.50	1.00	20.50	Underused	95.12
Fry/Fingerling cost (NRs./ha)	28494.16	0.125	7.20	1.00	7.20	Underused	86.11
Feed cost (NRs./ha)	252915.2	0.177	1.15	1.00	1.15	Underused	13.04
Lime, fertilizer and medicine cost (NRs./ha)	34949.72	0.030	1.41	1.00	1.41	Underused	29.08
Fuel and electricity cost (NRs./ha)	28701.37	-0.023	-1.31	1.00	-1.31	Overused	176.34
Labour cost (NRs./ha)	304531.1	0.264	1.42	1.00	1.42	Underused	29.58

The adjustment in the MVPs for optimal resource use in Table 6 suggested that for optimal allocation of resources; pond maintenance, Hatchling/ Fry/ Fingerling, feed, lime, fertilizer and medicine, and labour costs were required to be increased by approximately 95%, 86%, 13%, 29% and 30% respectively. On the other hand, fuel and electricity cost was required to be reduced by approximately 176%. Overall result illustrates that, all the inputs were not utilized to optimum economic advantage. The findings were in line with Elhendy and Alzoom (2008) where none of the resources were found to be utilized to optimum.

CONCLUSION

This study showed that the fish could be harvested up to four times in a year. Almost similar practices of rearing were followed for chhari and marketable-size carps, but more profit was generated by the chhari producers. There were fewer problems in the marketing of harvested fish, which indicated the demand and potentiality of fish farming in the country. The analysis of the resource use efficiency indicated that none of the resources were utilized to optimum condition in either of the categories. So, rather than expanding further land area for production it is important to increase the quantity of under-utilized resources as mentioned above and decrease the quantity of over-utilized resources. Though farmers were found to be benefitted from the fish farming, more output and more production can even be generated if resources are used to optimum. When all the production problems like lack of access to capital, adequate supply of quality fingerlings and feed, technical services availability etc are subjected; it will not take much time to be self-sufficient in fish commodity.

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Author contributions

P.A designed and performed experiments; P.A, M.P, and S.G analyzed the data and P.A. prepared the manuscript in consultation with D.K.J. and M.A.; D.K.J approved the final manuscript.

Conflict of authors

The authors declare that there is no conflict of interest regarding the publication of this paper.

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